DOES THE SOCIAL CONTENT OF THE PROBLEM INFLUENCE CONDITIONAL REASONING? AN EXPERIMENTAL APPROACH USING THREE CARD SELECTION TASKS

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Abstract
This study aimed to investigate the possible differences regarding the accuracy of modus ponens and modus tollens inference rules depending on the content of the given conditional problem.

As a main hypothesis, I presumed that the overall conditional reasoning and the modus tollens argument would be correctly applied in a higher proportion when the content of the problem referred to a concrete social situation, rather than when it was expressed in an abstract form.

The 111 participants – persons (Mage = 26.86; SD = 10.21) with various occupations – were equally assigned to three independent groups defined by a different version of a card selection problem similar to the one proposed by Wason in 1966 (as cited in Goldstein, 2008).

Overall, the obtained results sustained the general hypothesis according to which the participants’ answers would be affected by the content of the reasoning problem. Modus tollens was selected more frequently when the conditional statement reflected a social context rather than when it had an abstract formulation. Contrary to my expectations, there were not found statistically significant differences between the three groups, regarding the percentage of the participants who had a correct overall reasoning. Some other important findings were also thoroughly discussed.

Cuvinte cheie: raționamentul condițional, modus ponens, modus tollens, negarea antecedentului, afirmarea consecventului.

Keywords: conditional reasoning, modus ponens, modus tollens, denying the antecedent, affirming the consequent.

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1. INTRODUCTION

Reasoning has been defined as a systematic process of thought that consists of drawing conclusions or inferences from evidence and principles (John-Laird, 1999; Sternberg, 2004) and represents one of the most important ability of the human cognitive system.

Over time, reasoning has been classified in many different types but the most common distinction that psychologists along with philosophers have stated, is the one between deductive and inductive reasoning. These two forms of reasoning differentiate one from another by the fact that the deductive reasoning goes from the general to the particular, implies conclusions that comprise no new information, excepting the one that already existed in the premises, and leads to conclusions that could not be false if the premises were true (deductive validity), while the inductive reasoning goes from the specific to the general, can lead to inferences that imply new information, and results in conclusions that can be true with a varied degree of probability (Galotti, 2008). Moreover, deductive reasoning has been divided in many forms but the most popular and studied ones are conditional reasoning and syllogistic reasoning.

So, this article is focused on conditional reasoning, defined as a form of deductive reasoning, that involves drawing a conclusion starting from a set of two premises: one that expresses a relation formulated as an “if P then Q” sentence, and one that affirms or negates either P or Q proposition. The resulted inference consists of a statement regarding the proposition that was not part of the second premise. The P proposition is named “the antecedent”, while the Q proposition - “the consequent” because the conditional statement reflects the fact that Q follows P, if P happens (Sternberg, 2009). In addition, there are four different types of inferences from which only two are considered deductively valid because they are based on a pair of premises that can lead to a single corresponding and logically correct conclusion.

These two particular forms are called “modus ponens” and “modus tollens”. Modus ponens argument describes the situation in which the consequent is true when the conditional and the antecedent are true; in other words, it comprises the premises “if P then Q” and “P” that bring to conclusion “Q”. Modus tollens is the argument in which the “if P then Q” and “non Q” premises are used to infer “non P”. So, when the conditional is true and the consequent is false (“non Q” is true), the antecedent must be false (“non P” must be true). In both arguments each of the two conclusions are unique and there cannot be other possibilities (Oaksford, 2005).

On the other hand, the two invalid inferences consist either of affirming the consequent, or of denying the antecedent. In the first case, the premises “if P then Q” and “Q” should lead to conclusion “P”, while in the second case, the premises
“if P then Q” and “non P” should drive to conclusion “non Q”. However, both of these inferences, logically speaking, are considered deductive fallacies because they imply more than one possible conclusion. In other words, stating that the consequent is true does not necessarily mean that the antecedent is also true, and similarly, stating that the antecedent is false does not necessarily mean that the consequent is necessarily false even though in both cases the conditional is true (Eysenck & Keane, 2000).

Over time, many researchers have tried to explain the complicated mechanisms behind people’s way of reasoning and one of the most known and commonly applied methods was presenting the participants with the Wason’s selection problem or a modified version of it depending on the theoretical framework and the hypothesis that were to be tested. In the original form, participants are asked to choose the minimum number of two-sided cards out of four, that are needed in order to check whether a given conditional rule is true or not. The content of the conditional statement is abstract, referring to numbers (even or odd) and letters (consonants or vowels) and the cards correspond to the four types of inferences previously described (modus ponens, modus tollens, affirming the consequent and denying the antecedent). For example, in his first experiment from 1966, Wason (as cited in Goldstein, 2008) used the conditional statement “If a card has a vowel on one side, then it has an even number on the other side”, and asked the participants to verify it by turning the cards that they considered necessary. The upper faces of the four cards were E, K, 4 and 7. The participants knew that each card that has a letter on one side had a number on the other side, and vice versa. Consistent with the explanations presented in the preceding paragraphs, the correct answers to the problem were E (modus ponens) and 7 (modus tollens) because both implied the possibility that the rule could be false, while none of the other two cards said something about this. Back in 1966, 53% of the participants applied correctly modus ponens, but only 4% of them recognized that denying the consequent (picking 7) was also needed to test adequately the conditional statement.

These results were surprising and controversial especially because, as Oaksford and Chater (2009) mentioned, they contradicted the emerging logicist paradigm in cognitive science, sustained by many important cognitivists such as: Piaget (e.g., Inhelder & Piaget, 1955) who stated that, at one point in the cognitive development (“formal operational stage”), the mind acquires the capacity to function according to a propositional logic system; Newell and Simon (e.g., 1972) who created the Logic Theorist and General Problem Solver, two computer programs developed to simulate the human cognitive system; or Chomsky (1957, 1965) who emphasized that the syntactic structure of reasoning could be organized in a deductive logical system that produces the grammatical structure of the sentences.
Synthesizing, according to the logicist theories, the mind is dominated by
domain-independent rules that correspond closely to those in standard logic
(Cheng, Nisbett, Oliver & Holyoak, 1986). Moreover, these formal rules are
considered to be pure syntactical and dependent exclusively on the logical form of
the premises but not on the content of the premises or the characteristics of the
situation (Posner, 1989). Therefore, the massive fallacious answers repeated in
many subsequent experiments that used the affirmative abstract version of Wason’s
task, were very puzzling. For example, Oaksford and Chater (1994) showed in a
meta-analysis of 34 studies, conducted by 13 different authors, that, from a total of
845 participants, 89% selected the “confirming the antecedent” card (modus
ponens) and only 25% selected the “denying the consequent” card (modus tollens),
the most preferred second answer (65%) being instead the “affirming the
consequent” card which is incorrect. In addition, there were also many results that
reflected a general tendency of people to answer correctly in a higher proportion
when the abstract items were replaced with real-world situations (Goldstein,
2008). Consequently, these unexpected discrepancies challenged many researchers to seek
alternative theories that could explain human reasoning.

However, the fundamental logicist view that human thought is based on a
system of formal mental logic remained the core conception of two of the most
important contemporary approaches to reasoning, mental logic and mental models
theories.

According to the mental logic theories, individuals possess a mental logic that
consists of a set of inference rules different from the ones in standard logic by their
elementary nature (Evans, Newstead & Byrne, 1993). Consequently, from this
point of view, the tendency of the people to apply correctly modus ponens in a
proportion significantly higher than modus tollens was explained by the fact that
they had an inference rule only for modus ponens and not for modus tollens as well
(Oaksford, 2005). One of the most representative mental logic theory is the one
proposed by Braine and O’Brien (1998) who stated the existence of three
components that explain the mechanisms behind human reasoning: 1) the lexical
entry that refers to the meaning of the words, stored in semantic memory and that is
different from the subjective meaning that one could apply depending on various
factors; 2) a reason program that reflects one’s specific mode of using the chain of
inferences, underlying the reasoning process; 3) the pragmatic principles that
explain the contextual factors that influence the interpretations of the premises (for
example, the frequently occurring situations should be easier to solve than the
uncommon ones).

In addition, Rips (as cited in Andrade & May, 2004) proposed a similar model
called PSYCOP (an improved version of his initial model, ANDS) that reflected a
“natural deduction” approach consisting of recognizing the possibility of the rules
to be applied both forward from a set of propositions to a conclusion, and
backwards from a conclusion to the premises. Moreover, Rips (as cited in
Oaksford, 2005) explained the high frequency of fallacious answers to conditional reasoning problems, by stating the complexity of the “reduction ad absurdum” inference strategy needed for modus tollens.

On the other hand, mental model theories are consistent with mental logic theories because they sustain the existence of the underlying logical structure that makes people capable of reasoning but, contrary to them, argue that, when reasoning, people operate with representations rather than directly applied formal rules (e.g., Johnson-Laird, as cited in Oaksford, 2005). Thus, these representations called models, comprise propositional-like tags, rather than be intrinsically propositional (O’Brien, 1998). According to this theory, reasoning entails constructing models for the situations described in the premises, evaluating systematically the driven conclusions that each of them comprises, and finally searching for counter-examples to each of the models in order to decide if the conclusions still remain valid for them. Moreover, the model suggests that reasoning errors are a result of the people’s failure to construct relevant counter-examples (Chater & Oaksford, 2001). More punctually, with regard to the conditional problems as the one from Wason’s selection task, Johnson-Laird and Byrne (as cited in Evans et al., 1993) explained the difficulty in applying modus tollens compared to modus ponens, by the fact that modus tollens requires fleshing-out of the initial models, while modus ponens can result directly from them.

Another representative theory that tried to clarify the way participants’ have responded to conditional problems in various experiments, consisted of eliminating the underlying logic rules and postulating the influence of both the content of the problem and personal experience regarding the circumstances described in the problem (Cheng et al., 1986). A representative experiment in support of this conception was the one conducted by Griggs and Cox (as cited in Sternberg, 2009) in which participants had to resolve two selection reasoning problems: one equivalent to Wason’s version, and one with a different content but identical logical form. The results showed that participants’ performance was better when they were confronted with the modified version of the problem in which they were put in the posture of an officer who had to enforce the law regarding the appropriate age for consuming beer (Sternberg, 2009). However, the subsequent similar research was inconsistent in supporting the facilitating role of the familiar content. For example, Cox and Griggs (1982) showed in three experiments regarding the effects of experience on conditional reasoning that, unexpectedly, the rate of the correct responses decreased when drinking alcohol problem was preceded by apparel color and abstract problems. Moreover, Kirby (as cited in Sternberg, 2009) used two versions of the drinking problem and revealed that the participants were more likely to apply modus tollens when the person described in the consequent had 18 years old, compared to the version in which this person had 4 years old.
Contrary to the precedent opposite views, Cheng and Holyoak (1985) proposed a new theory according to which people’s reasoning could be explained neither by the content-free syntactic inference rules nor by the representations or memories of specific experiences. Instead, they introduced the “pragmatic reasoning schema” concept that refers to a number of abstract knowledge structures, such as “permissions”, “causations”, “obligations” etc., formed as a result of the everyday experience (Cheng & Holyoak, 1985). More precisely, the authors defined pragmatic reasoning schemas as clusters of generalized context-sensitive rules associated with specific classes of goals (desirable actions, predictions etc.) and relationships to these goals (precondition, cause and effect, allowable action etc.). These rules may be more complex than the purely syntactic rules of logic because they are applicable in interpreting both “non-logical” and formal logic terms (Cheng & Holyoak, 1985). Moreover, according to Cheng et al. (1986), the rules comprising pragmatic schemas are frequently used in solving a diversity of problems and therefore could lead to the same solutions as the standard logic rules, but, despite this apparent consistency between them, the two types of rules must not be confounded one to another, considering that sometimes people may generate responses contradictory to the rules of logic that other times had been kept. According to the theory of pragmatic schemas, participants’ performance tends to be consistent with the correct standard logical answers when the content of the stated rule activates a schema and the concordance between the stated rule and the rules of the evoked schema is similar to the way the latter map onto rules of standard logic (Holyoak & Cheng, 1995).

In response to Cheng and Holyoak’s (1985) theory as well as to the abstract deductive reasoning principles, Cosmides (1989) published an extensive article in which she proposed an evolutionary perspective on human reasoning, sustained by a set of nine studies. However, although the new theory called “the social contract theory” was initially introduced as an alternative to the pragmatic reasoning schema theory, some authors considered Cosmides’ (1989) theory as being just a particular version of the one developed by Cheng and Holyoak (1985), taking account of the fact that the social contracts could be viewed as a particular form of pragmatic schemas (Leighton & Sternberg, 2003). Still, one main difference between the two approaches is that Cosmides (1989) based her theory on a series of assumptions different from the ones advanced by Cheng and Holyoak (1989). Firstly, the theory states the fact that humans possess a number of so-called “Darwinian algorithms” defined as specialized learning mechanisms that organize experience into meaningful schemas or frames with adaptive value in the context of evolutionarily important problems (Cosmides, 1989). More precisely, as the author have stated, these algorithms should have the capacity to focus attention, organize perception and memory and facilitate domain-appropriate inferences, judgments and choices by activating the necessary specialized procedural knowledge. One essential domain that requires one such algorithm, named social-contract
algorithm, is any kind of social exchange situation that involves the cooperation between two or more individuals for obtaining mutual benefit. In other words, this algorithm is activated in situations with cost-benefit consequences that may involve potential cheaters (Cosmides, 1989). Moreover, according to Cosmides’ (1989) theory, the differences in reasoning errors that appear in Wason’s selection task are explained by the fact that the abstract content of the problem does not have the power to induce the social contract algorithm.

Another evolutionary theory, closely related to the social contract theory, is the cheating detection theory proposed by Gigerenzer and Hug (1992) who emphasized the influence of reasoners’ perspective on the answers that they gave to reasoning problems. According to this theory, there are two kinds of social contracts: 1) the contracts with bilateral cheating options that refer to the situations in which changing the perspective from party A to party B implies also a change in the way cheating is interpreted: from the perspective of party A, “not-P” and “Q” reflects the fact that party B cheats party A, while from the perspective of party B, “P” and “not-Q” means that party A cheats party B; 2) the contracts with unilateral cheating options that refer to the situations in which the same party perform the actions from the antecedent as well as the ones from the consequent. Consequently to this distinction, the main assumption of the theory is that the answers given by the individuals when confronted with a reasoning problem are different when they embrace the role of the recipients of the benefit, than when they embrace the role of the bearers of the cost.

In conclusion to this review of the literature, as Cheng and Holyoak (1989) remarked, the pragmatic reasoning theory and the social contract theory at which I would add cheating detection theory, are all situated at the middle of the distance between the approaches that sustain that people reason using domain-independent formal rules (e.g., Braine, 1978; Rips, 1983) and the approaches that consider reasoning to be dependent on the memory of the domain-specific experiences (e.g., Griggs & Cox, 1982). Secondly, from a detached point of view, the main theories of reasoning, identified in the literature could be categorized in two groups depending on their tendency to attribute a greater or a smaller importance to the context reflected by the problem, in an attempt to explain the mechanisms behind human reasoning.

2. OBJECTIVES AND HYPOTHESES

2.1. OBJECTIVES

The general objective of this study was to analyze the possible influence that the content of the problem could have on the accuracy of conditional reasoning.
More precisely, I aimed to calculate the percentage of modus ponens and modus tollens correctly applied inference rules, as well as the one for overall correct reasoning and to compare each value obtained in three experimental conditions defined by a different given conditional problem: one with an abstract content, one with a specific content related to a particular social situation, and one with the same social content but with inverted antecedent and consequent.

Similarly, I intended to determine the percentage of denying the antecedent and affirming the consequent reasoning errors for the three experimental tasks, in order to see whether each one of them was significantly different depending on the way the conditional problem was formulated.

2.2. HYPOTHESES

I presumed that the overall conditional reasoning would be applied correctly in a higher proportion when the content of the problem would reflect a particular social context that implies a possible cheater. Moreover, I hypothesized that this result would be obtained regardless of the order of the antecedent and the consequent of the social problem.

Secondly, I expected no differences between the three experimental groups, regarding the general tendency to recognize modus ponens as a necessary condition for checking whether the given conditional statement was true or false.

On the other hand, I presumed that modus tollens rule would be selected correctly significantly more often in the case of each of the two social content problems, compared to the abstract problem situation.

Complementary to the previous hypotheses, and considering the results of the meta-analysis conducted by Oaksford and Chater (1994), I presumed that the number of affirming the consequent fallacy would be significantly higher when the participants would have to resolve the abstract problem, compared to both social content problems, while there would not be significant differences regarding denying the antecedent reasoning fallacy.

Lastly, I expected to obtain not statistically significant differences regarding participants’ responses to the first version of the social content problem (version 1) compared to the ones given to the social content with inverted antecedent and consequent (version 2). The main argument behind this hypothesis was the fact that the contents of the two problems were not fundamentally different. The only distinction between them was the order of the antecedent and the consequent propositions, but not the relation between them. However, I opted to explore this hypothesis, in order to obtain some possible scientific evidence for my presupposition.
3. METHOD

3.1. PARTICIPANTS

At this research participated 111 persons with a mean age of 26.86 years old ($SD = 10.21$). There were 82 females and 29 males, partly second and third year psychology students, partly persons with various occupations. All of them were Romanians.

The study included three independent groups, each of them comprised of 37 participants, assigned according to the three experimental conditions. Although in the literature I could not identify significant research to sustain some differences regarding people's reasoning depending on their gender, age or occupation, I preventively aimed to maintain a relative equivalence between the three groups by minimally controlling these possible intermediate variables. Therefore, each group contained approximately the same mean age and the same proportion of psychology students versus persons with other occupations, as well as females versus males. Consequently, the selection of the participants was a result of a pseudorandom process applied firstly among psychology students and secondly among adults with various occupations. All participants were volunteers.

The first group had to solve an abstract card selection problem and comprised 9 males and 28 females, from whom 27 were psychology students and 10 adults. The mean age of the group was 25.57 years old, $SD = 10.06$.

The second group received the first version of the card selection problem that had a social content and comprised 11 males and 26 females, from whom 29 were psychology students and 8 adults. The mean age of the group was 26.95 years old, $SD = 10.36$.

The third group was asked to resolve the second version of the social content problem, in which the antecedent and the consequent were inversed. This group included 10 males and 27 females, from whom 26 were psychology students and 11 adults. The mean age of the group was 25.93 years old, $SD = 10.11$.

3.2. MATERIALS

The materials that I used were three card selection conditional reasoning problems which I created having as model the task proposed by Wason in 1966 (as cited in Goldstein, 2008). Each of them represented a different experimental condition and therefore was used for only one of the three groups.

All three problems consisted of a conditional statement that was needed to be verified whether it was true or false, by selecting two cards out of four. The cards were symbolized by drawn squares that comprised the equivalent information for
the four possible rules of inference – modus ponens, modus tollens, denying the antecedent or affirming the consequent.

The first problem had an abstract content that referred to words in different languages and geometric figures (plane or space shapes), instead of letters and numbers like in Wason’s problem. The conditional statement was “If a card has a space shape on one side, then it has a Romanian word on the other side”. The upper sides of the four cards were: “triangle”, “muzică” (Romanian word for “music”), “voorjaar” (Dutch word for “spring”), “cube”.

The second problem was designed to transpose the participants in the role of a school inspector who had to check whether a teacher was giving students the appropriate marks. The instructing was as follows:

“Imagine that you are a school inspector who must check whether the teacher gave his students the marks that they deserved, according to their level of knowledge. For this, you gave students a 20 items knowledge test in order to compare the obtained score with the mark that they had received from their teacher.

You know that “If a student had an A, then he should answer correctly to all 20 items of the test”. The following two-sided cards contain information about four students. On one side of a card is the student’s mark while on the other is his test score. You have to select two of them that you need in order to evaluate the teacher’s correctness in giving marks.”

The upper sides of the four cards were: “20 correct answers”, “C”, “A”, “13 correct answers”.

The third task was identical to the second one, excepting the fact that the antecedent and the consequent of the given conditional statement were inversed. Thus, they were instructed that they knew that “If a student answers correctly to all 20 items of the test, then he should have received an A” instead of “If a student had an A, then he should answer correctly to all 20 items of the test”.

The second and the third problems are typical for a social contract situation that imply unidirectional cheating because the participants were put in the posture of an authority. Moreover, both conditional statements reflect the same relation between the proposition regarding students’ mark and the one regarding students’ test score, even though for each the two versions of the problem they occupy different positions, being either the antecedent or the consequent.

However, I opted for these two versions because the initial social problem that I created had a slightly different wording from the ones commonly used in the previous studies (e.g., Cox & Griggs, 1992) in which party A had to check a condition regarding party B, expressed through a conditional statement that included clearly party B in both propositions. Conversely, in my problem, party B (the teacher) was not explicitly mentioned in neither the antecedent nor the consequent. Instead, the two propositions included information about the student’s test performance and the mark that they had received from the teacher. Therefore, I considered necessary to supplementary explore the possibility of identifying some
differences in participants’ answers depending on the order of the propositions, even though I did not expect to obtain statistically significant results regarding the comparisons between the two versions of the social problem.

3.3. PROCEDURE

Two thirds of the participants completed a paper version of the research form, while the other third used a Word document with exactly the same information.

The instructing was standardized for all participants, considering the fact that it was included on the answer form. Thus, the participants received information about the purpose of the study and the implications derived from their participation (confidentiality of the data, no exposure to any kind of risks or negative consequences, the voluntary and anonymous nature of their participation, their right to retreat at any time during the study or to refuse to answer any questions). The content of the problem and the explanations regarding the answering procedure were also presented on the answer form.

Participants completed the task individually, depending on their personal availability and without time limit.

3.4. EXPERIMENTAL DESIGN

The study implied two independent variables: 1) the content of the conditional reasoning problem, comprising two levels - abstract versus concrete/social content; 2) the order of the P and Q propositions in the conditional social content statement.

The dependent variables were the accuracy of overall conditional reasoning, operationalized by selecting simultaneously modus ponens and modus tollens arguments, as well as the degree to which participants were inclined to use each of the four arguments in order to check the truth-value of the given conditional statement.

In other words, this study comprised multiple 2x2 designs organized on three sections depending on the levels of the two independent variables. In the first section, I aimed to investigate whether each of the proportion of correct conditional reasoning, modus ponens, modus tollens, affirming the consequent and denying the antecedent, would be statistically significant different when the problem was presented with the social content (version 1), compared to the abstract content version of the problem. Similarly, in the other two sections I aimed to analyze the differences in the dependent variables, when the content of the problem was social (version 2) versus abstract, and social (version 1) versus social (version 2).
4. RESULTS

The participants’ answers were encoded using “yes” or “no” labels to suggest what inference rules they had selected as being necessary to check whether the conditional statement (regardless of its content) was true or false. Thus, all variables were categorical.

Consequently, the hypotheses were verified using chi-squared test for independence. The results are presented in Tables 1-3.

The frequency analysis for the entire group of participants \(N = 111\), regardless of the content of the problem, indicated that 66.5% of them selected modus ponens and 35.1% selected modus tollens, while 57.7% selected affirming the consequent and 40.5% selected denying the antecedent. Only 12.2% of the answers comprised both modus ponens and modus tollens arguments suggesting a correct overall conditional reasoning.

Table 1. The percentage of each argument selection within the abstract and the social content (v.1) problems, as well as the results of the chi-squared test for independence

<table>
<thead>
<tr>
<th>Conditional reasoning</th>
<th>Content of the problem</th>
<th>(X^2)</th>
<th>(X^2) (Yates)</th>
<th>(\phi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modus ponens</td>
<td>Abstract 91.9%</td>
<td>13.43**</td>
<td>11.58**</td>
<td>.42</td>
</tr>
<tr>
<td></td>
<td>Social (v.1) 54.1%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modus tollens</td>
<td>Abstract 10.8%</td>
<td>7.34**</td>
<td>5.94*</td>
<td>.31</td>
</tr>
<tr>
<td></td>
<td>Social (v.1) 37.8%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Affirming the consequent</td>
<td>Abstract 81.1%</td>
<td>3.25</td>
<td>2.39</td>
<td>.21</td>
</tr>
<tr>
<td></td>
<td>Social (v.1) 62.2%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Denying the antecedent</td>
<td>Abstract 16.2%</td>
<td>7.63**</td>
<td>6.30*</td>
<td>.32</td>
</tr>
<tr>
<td></td>
<td>Social (v.1) 45.9%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall conditional reasoning</td>
<td>Abstract 5.4%</td>
<td>2.24</td>
<td>1.26</td>
<td>.17</td>
</tr>
<tr>
<td></td>
<td>Social (v.1) 16.2%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. \(N = 37\) for each group.

\(p < .05; ** p < .01\)

According to my hypothesis, the participants who answered to the social content (v.1) problem were more inclined to recognize that denying the consequent was indispensable to check the truth-value of the given conditional statement, compared to those that received the abstract problem. As the effect size value (\(\phi = .31\)) suggests, the association between the content of the problem and the frequency of modus tollens answers, was medium. Moreover, the odds ratio indicates that if the problem had a social content (v.1), one was 5.02 times more likely to select modus tollens answer.

One the other hand, contrary to the expectations, the percentage of participants who applied modus ponens rule was significantly higher when the problem was abstract compared to when it referred to a social context (v.1), and there were no differences regarding the accuracy of the overall conditional reasoning across the two experimental conditions. In addition, when the problem was abstract, the participants had a lower tendency to deny the antecedent, rather than be more inclined to affirm the consequent as I presumed. Thus, one had 4.39 times more chances to select the “deny the antecedent” card if he answered the
social content problem (v.1) than the abstract one. In this case, the effect size was medium. However, there were not statistically significant differences regarding the frequency of negating both P and Q propositions (applying simultaneously modus tollens and denying the antecedent), Χ² (1, \(N = 74\)) = 1.42, \(p > .05\).

Table 2. The percentage of each argument selection within the abstract and the social content (v.2) problems, as well as the results of the chi-squared test for independence

<table>
<thead>
<tr>
<th>Conditional reasoning</th>
<th>Content of the problem</th>
<th>Abstract</th>
<th>Social (v.2)</th>
<th>(\chi^2)</th>
<th>(\chi^2) (Yates)</th>
<th>(\phi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modus ponens</td>
<td>91.9%</td>
<td>54.1%</td>
<td>13.43**</td>
<td>11.58**</td>
<td>.42</td>
<td></td>
</tr>
<tr>
<td>Modus tollens</td>
<td>10.8%</td>
<td>56.8%</td>
<td>17.45**</td>
<td>15.46**</td>
<td>.48</td>
<td></td>
</tr>
<tr>
<td>Affirming the consequent</td>
<td>81.1%</td>
<td>29.7%</td>
<td>19.74**</td>
<td>17.72**</td>
<td>.51</td>
<td></td>
</tr>
<tr>
<td>Denying the antecedent</td>
<td>16.2%</td>
<td>59.5%</td>
<td>14.70**</td>
<td>12.92**</td>
<td>.44</td>
<td></td>
</tr>
<tr>
<td>Overall conditional reasoning</td>
<td>5.4%</td>
<td>16.2%</td>
<td>2.24</td>
<td>1.26</td>
<td>.17</td>
<td></td>
</tr>
</tbody>
</table>

Note. \(N = 37\) for each group.

* \(p < .05\); ** \(p < .01\)

The results obtained for the abstract problem and the social content (v.2) problem conditions were similar to the previously discussed ones, with regard to the participants’ frequency in applying modus ponens, modus tollens and denying the antecedent rules. The relation between each of these three dependent variables and the content of the problem variable was quite strong, as the \(\phi\) values show. The odd ratios suggest that if one received a problem that reflected a cost-benefit social situation (v.2), he was 10.82 times more likely to select modus tollens rule and 7.57 times more likely to deny the antecedent, than if he received the abstract problem. Moreover, contrary to my hypothesis, there was not a statistically significant difference between the percentage of participants who had a correct overall reasoning in the first experimental condition, compared to the percentage of those from the second condition.

Conversely, according to my expectations, the participants who received the abstract problem selected more frequently the “affirming the consequent” card, than the participants who received the social content (v.2) card. More precisely, one had 10.12 times more chances to commit this reasoning fallacy if the conditional statement was abstract. The effect size value was large.

Moreover, the percentage of participants who had to solve the social content (v.2) problem (32.4%), was significantly higher than the percentage of participants who received the abstract version of the problem (5.4%), Χ² (1, \(N = 74\)) = 8.81, \(p < .01\). The \(\phi\) value indicated a medium effect size for the association between the content of the problem variable and this combination of arguments.
Table 3. The percentage of each argument selection within the social content (v.1) and the social content (v.2) problems, as well as the chi-squared test for independence

<table>
<thead>
<tr>
<th>Conditional reasoning</th>
<th>Content of the problem</th>
<th>$\chi^2$</th>
<th>$\chi^2$ (Yates)</th>
<th>$\phi$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Social (v.1)</td>
<td>Social (v.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modus ponens</td>
<td>54.1%</td>
<td>54.1%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Modus tollens</td>
<td>37.8%</td>
<td>56.8%</td>
<td>2.65</td>
<td>1.95</td>
</tr>
<tr>
<td>Affirming the consequent</td>
<td>62.2%</td>
<td>29.7%</td>
<td>7.83**</td>
<td>6.58**</td>
</tr>
<tr>
<td>Denying the antecedent</td>
<td>45.9%</td>
<td>59.5%</td>
<td>1.35</td>
<td>.86</td>
</tr>
<tr>
<td>Overall conditional reasoning</td>
<td>16.2%</td>
<td>16.2%</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Note. $N = 37$ for each group.

* $p < .05$; ** $p < .01$

The statistical results were consistent with my presuppositions according to which the inversion of the antecedent with the consequent of the social content problem would have no significant influence on the participants’ tendency to apply modus ponens, modus tollens, to deny the antecedent or to have a correct overall reasoning.

However, contrary to my expectations, the group who received the first version of the problem thought significantly more frequent that the “affirming the consequent” inference fallacy was needed to check whether the conditional statement was true or false, than the group exposed to the second version of the problem. The odds for a person to select this card were 3.88 times higher if the given problem was presented in the first version of the social content. The association between the independent variable and the frequency of the affirming the consequent response was medium.

The contingency table showed that 32.4% of the participants who received the second version of the social problem selected both modus tollens and denying the antecedent arguments, while only 13.5% of the participants from the first group answered this way, suggesting a possible influence of the problem’s version, on the tendency of the participants to negate both P and Q propositions. However, this difference was not statistically significant, $\chi^2 (1, N = 74) = 3.74, p > .05$.

5. CONCLUSIONS

The impressive number of explanations regarding the mechanisms behind human reasoning seems to have a general tendency to follow two main theoretical directions: one that emphasizes mainly the existence of a cognitive substructure of domain-independent abstract rules of reasoning and one that rather states the importance of the domain-specific experiences. Between these approaches, there could be identified another category of theories that borrow principles and ideas from both opposite poles, reuniting them in a novel conception but still being more inclined towards one direction or another.
The results obtained in this study could provide some minimal evidence to support the theories that highlight the general idea according to which the context reflected by the conditional statement could influence participants’ answers on Wason’s card selection task - maybe the most applied but also controversial method in the research of conditional reasoning. More precisely, considering the fact that the content of the problems that I designed for the experimental conditions refers to a particular cost-benefit social situation in which an authority could be cheated, my findings could be concordant especially with the pragmatic reasoning schemas theory (Cheng & Holyoak, 1985), social contract theory (Cosmides, 1989) and cheating detection theory (Gigerenzer & Hug, 1992).

Thus, according to the expectations based on the previous research (e.g., Cheng & Holyoak, 1985; Fiedler & Hertel, 1994; Griggs & Cox, as cited in Sternberg, 2009; Platt & Griggs, as cited in Eysenck & Keane, 2000), the participants who had to verify both conditional statements that implied the possibility of an incorrect students’ academic performance evaluation, were more likely to think that modus tollens was an essential argument for this, compared to those who had to solve the abstract card selection task. From an evolutionary perspective (e.g., Cosmides, 1989), these results could suggest the activation of an algorithm for a look-for-cheaters procedure that could enable individuals to use correctly modus tollens inference rule, usually very difficult to understand. Moreover, this interpretation might be sustained by the fact that the proportion of answers that included both modus tollens and denying the antecedent arguments was significantly higher when the given problem was expressed through the second version of the social content compared to the abstract content, indicating a possible supplementary focus of attention on anyone who had taken a benefit without deserving it. This tendency, although not statistically significant, was also observed for the first version of the social problem but it is important to take account of the lack of statistical power implied mostly by the very small samples of participants.

On the other hand, the contradictory results regarding the possible influence of inversing the social problem’s antecedent and consequent, on the participants’ reasoning, as well as the not confirmed hypotheses regarding modus ponens rule, or the fact that the overall conditional reasoning was not improved in neither social content experimental conditions, may also reflect the complexity and difficulty of explaining human reasoning in general, but also in particular using selection card tasks because, at least in this case, as some authors sustained there could intervene different intermediate variables like the perceived relation between the antecedent and the consequent (e.g., Ahn & Graham, 1999; Thompson, 1994) or the misinterpretations of the conditional statements (e.g., Gebauer & Laming, 1997; Osman & Laming, 2001), that are very problematic or even impossible to control by the researcher.

In conclusion, despite the methodological and theoretical limits, overall, this study might reflect the fact that the content of the problem could affect the way
participants selected their arguments in order to check the truth value of a conditional statement.

REFERENCES


O’Brien, D. P. (1998). Mental logic and irrationality: We can put a man on the moon, so why can’t we solve those logical reasoning problems?. In M. D. S. Braine & D. P. O’Brien (Eds.), Mental logic (pp. 23-44). Mahwah, USA: Lawrence Erlbaum Associates Inc.


REZUMAT

Studiul de față a avut drept obiectiv identificarea unor posibile diferențe privind corectitudinea aplicării regulilor de inferență modus ponens și modus tollens în funcție de conținutul problemei prezentate.

Principala ipoteză de la care am pornit a fost aceea că raționamentul condițional per total, și regula modus tollens, în particular, ar putea fi aplicate corect în proporție mai mare atunci când tematica problemei face trimitere la o situație socială concretă, decât atunci când aceasta este abstractă.

Cei 111 participanți - tineri și adulți (Mvârstă = 26.86 ; SD = 10.21) cu diverse ocupații - au fost împărțiți în mod egal în trei grupuri experimentale stabilite în funcție de cele trei probleme similare cu cea propusă de Wason în 1966 (apud Goldstein, 2008), utilizate în vederea manipulării variabilei independente.

Rezultatele obținute au susținut per ansamblu ipoteza generală potrivit căreia răspunsurile participanților ar fi putut fi influențate de modul în care a fost formulată problema de raționament. Modus tollens a fost selectat mai frecvent atunci când problema a descris o situație socială concretă decât atunci când a fost prezentată într-o formă abstractă. Contrar așteptărilor, nu au fost identificate diferențe semnificative între cele trei grupuri privind procentul participanților care au avut un raționament condițional global corect. Alte rezultate importante sunt de asemenea discutate pe larg în cadrul articolului de față.